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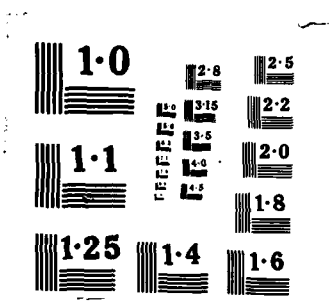
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UNDERWATER FACILITIES INSPECTIONS AND ASSESSMENTS AT

NAVAL AIR STATION WHIDBEY ISLAND, OAK HARBOR, WA

FPO-1-83-(41) SEPTEMBER 1983

PERFORMED FOR: OCEAN ENGINEERING AND CONSTRUCTION PROJECT OFFICE
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C. 20374

UNDER: CONTRACT N62477-81-C-0448
TASK 8

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BY: CHILDS ENGINEERING CORPORATION
MEDFIELD, MA

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19. ABSTRACT (Continue on reverse if necessary & identify by block number)
The objective of the Underwater Facility Assessments conducted at the Naval Air Station, Whidbey Island, Washington, is to provide a generalized structural condition report of certain facilities within the Activity. The facilities are Fuel Pier, Main (Finger Pier) Pier, Boat House, Runway (Con't)

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BLOCK 19 (Con't)

Approach Lights and the the Pumping Station Pier. Each facility was inspected by a team of Engineer/Divers using primarily visual and tactile inspection techniques. Typical and critical conditions were photo-documented.

The majority of the facilities exhibited some major structural damage. This damage is either the result of impact damage of marine borer attack. Repair of the damaged structural piles is of primary importance.

The Fuel Pier is generally in good condition. No reduction of pier capacity is recommended. The major structural anomaly is the damage to two (2) piles in the berthing dolphin associated with the pier.

The Main Pier is in fair condition. Localized structural damage has reduced the pier's live-load capacity.

The Boat House is in fair condition. Marine borer attack has rendered several piles structurally deficient.

The Runway Approach Lights and the Pumping Station Pier facilities are in good condition with no significant structural anomalies noted.

The observed marine borer attack is a serious problem for the timber pile-supported structures. The presence of the borers indicates that the preservative treatment may have lost its effectiveness. Piles in the Fuel Pier, Main Pier and Boat House should be protected from further borer attack by wrapping the piles in protective plastic jackets.

EXECUTIVE SUMMARY

The objective of the Underwater Facility Assessments conducted at the Naval Air Station, Whidbey Island, Washington, is to provide a generalized structural condition report of certain facilities within the Activity. The facilities are Fuel Pier, Main (Finger Pier) Pier, Boat House, Runway Approach Lights and the Pumping Station Pier. Each facility was inspected by a team of Engineer/Divers using primarily visual and tactile inspection techniques. Typical and critical conditions were photo-documented.

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NAVAL AIR STATION
WHIDBEY ISLAND, WASHINGTON
EXECUTIVE SUMMARY TABLE

FACILITY	YEAR BUILT	TOTAL NO. OF PILES	SIZE	STRUCTURES	RECOMMEN
Fuel Pier	Circa 1968	80 - Pier 7 - Dolphin	Pier: 181'x12' Approach: 70'x21'	Treated Round Timber Piles	1) Replace two dolphin. 2) Wrap struct prevent fur 3) Re-inspect thereafter.
Main Pier (Finger Pier)	Circa 1942	560	530'x50'	Treated Round Timber Piles	1) Replace/rep piles. 2) Wrap struct prevent fur 3) Re-inspect thereafter.
Boat House	Circa 1942	261	L-shaped 325'x70' and 220'x75'	Treated Round Timber Piles	1) Replace/rep 2) Wrap struct prevent fur 3) Re-inspect thereafter.
Runway Approach Lights	Circa 1970	10	N/A	Steel H-Piles	1) Replace and 2) Re-inspect thereafter.
Pumping Station Pier	Circa 1950	35	175'x10'	Treated Round Timber Piles	1) Re-inspect

NAVAL AIR STATION

WHIDBEY ISLAND, WASHINGTON

EXECUTIVE SUMMARY TABLE

STRUCTURES	RECOMMENDATIONS	ESTIMATED COST OF RECOMMENDATIONS
reated Round imber Piles	1) Replace two (2) damaged piles in dolphin.	$ 8,400.00
	2) Wrap structural piles in plastic to prevent further borer attack.	18,000.00
	3) Re-inspect after repair and 5 years thereafter.	
reated Round imber Piles	1) Replace/repair damaged and non-bearing piles.	22,000.00
	2) Wrap structural piles in plastic to prevent further borer attack.	252,000.00
	3) Re-inspect after repair and 5 years thereafter.	
reated Round imber Piles	1) Replace/repair damaged piles.	17,975.00
	2) Wrap structural piles in plastic to prevent further borer attack.	56,700.00
	3) Re-inspect after repair and 5 years thereafter.	
teel H-Piles	1) Replace anodes.	500.00
	2) Re-inspect after repair and 5 years thereafter.	
reated Round imber Piles	1) Re-inspect in 5 years.	

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF PHOTOGRAPHS

SECTION 1.0 INTRODUCTION

This report is a product of the Underwater Inspection Program conducted by the Ocean Engineering and Construction Project Office (FPO-1), Chesapeake Division, Naval Facilities Engineering Command (NAVFACENGCOM) under NAVFAC's Specialized Inspection Program.

This program sponsors task-oriented engineering services for the inspection, analysis and design, and monitoring of repairs for the submerged portions of selected Naval Waterfront Facilities. All services required to produce this report were provided by Childs Engineering Corporation of Medfield, Massachusetts under Task No. 8.0 of Contract No. N62477-81-C-0448.

1.1 REPORT CONTENT

The report contains a description of inspection procedures, the results of the inspection and analysis of the findings, accompanied by pertinent drawings and photographs. Specifically, the inspection results include a description of the location, existing facilities, its observed condition and a structural assessment of that condition. Recommendations for each facility include cost estimates (based on present local prices) for all repair work. Structural assessment calculations and cost estimate breakdowns can be found in the Appendix.

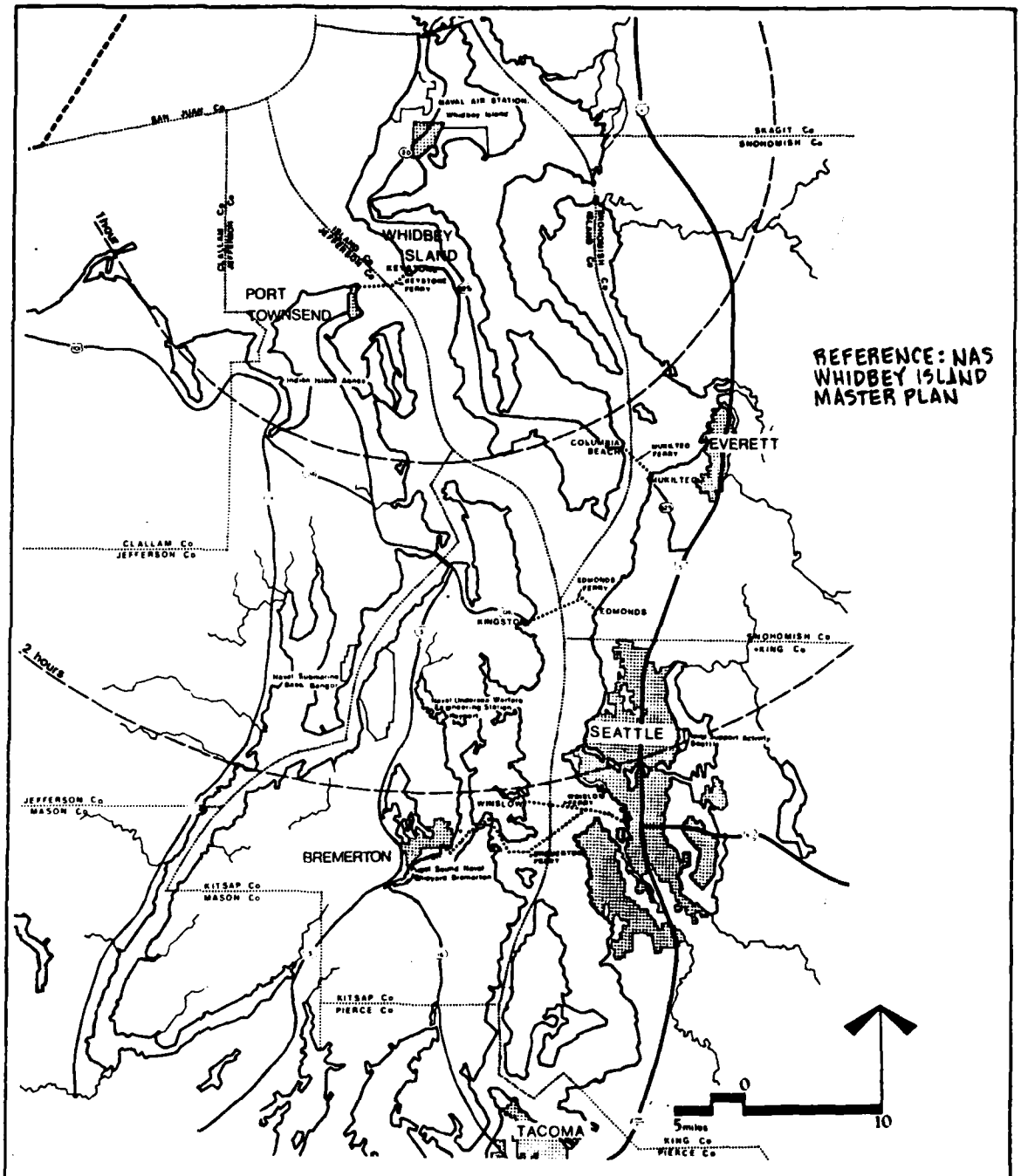
SECTION 2.0 ACTIVITY DESCRIPTION

The purpose of this section is to provide a general description of the Naval Air Station on Whidbey Island, Washington, including brief descriptions of the Naval Air Station's location and existing facilities. The information is provided to aid in identification of the facility and to support all considerations necessary to accurately assess the condition of facilities inspected under this task.

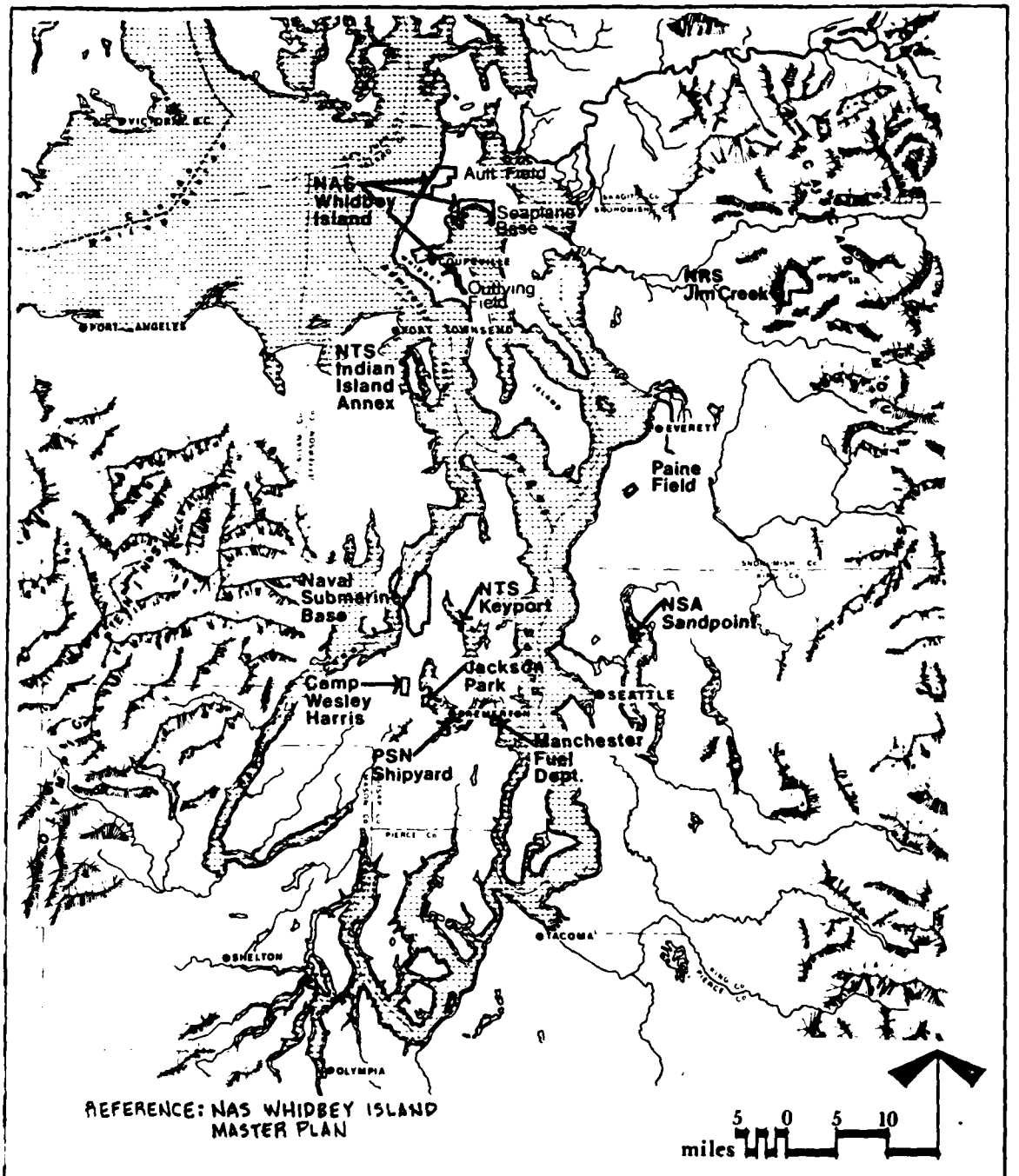
2.1 LOCATION OF ACTIVITY

The southern tip of Whidbey Island is located approximately 20 miles north of Seattle in Puget Sound. The island is 65 miles long and varies in width from one to ten miles (Figure 1).

Three noncontinguous properties of the Naval Air Station Complex are located on the north end of the island. All are located in Island County which includes Camino Island, immediately to the east, as well as Whidbey Island. Ault Field, the main base, lies north of the City of Oak Harbor, and south of Deception Pass State Park. It is bounded by the Strait of Juan de Fuca on the west and State Highway 20 and Dugualla Bay on the east. The Seaplane Base, primarily a support installation, is located in the City of Oak Harbor on Oak and Crescent Bays. Coupeville Airfield is approximately 20 miles further south, near the town of Coupeville, and is surrounded by farmland (Figure 2). (Reference 1)



GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 333 MEDFIELD, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C
AS SHOWN		NAVAL AIR STATION WHIDBEY ISLAND, WA — LOCATION MAP — FIG NO. 1



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AS SHOWN		NAVAL AIR STATION WHIDBEY ISLAND, WA VICINITY MAP	FIG NO 2

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2.2 EXISTING FACILITIES

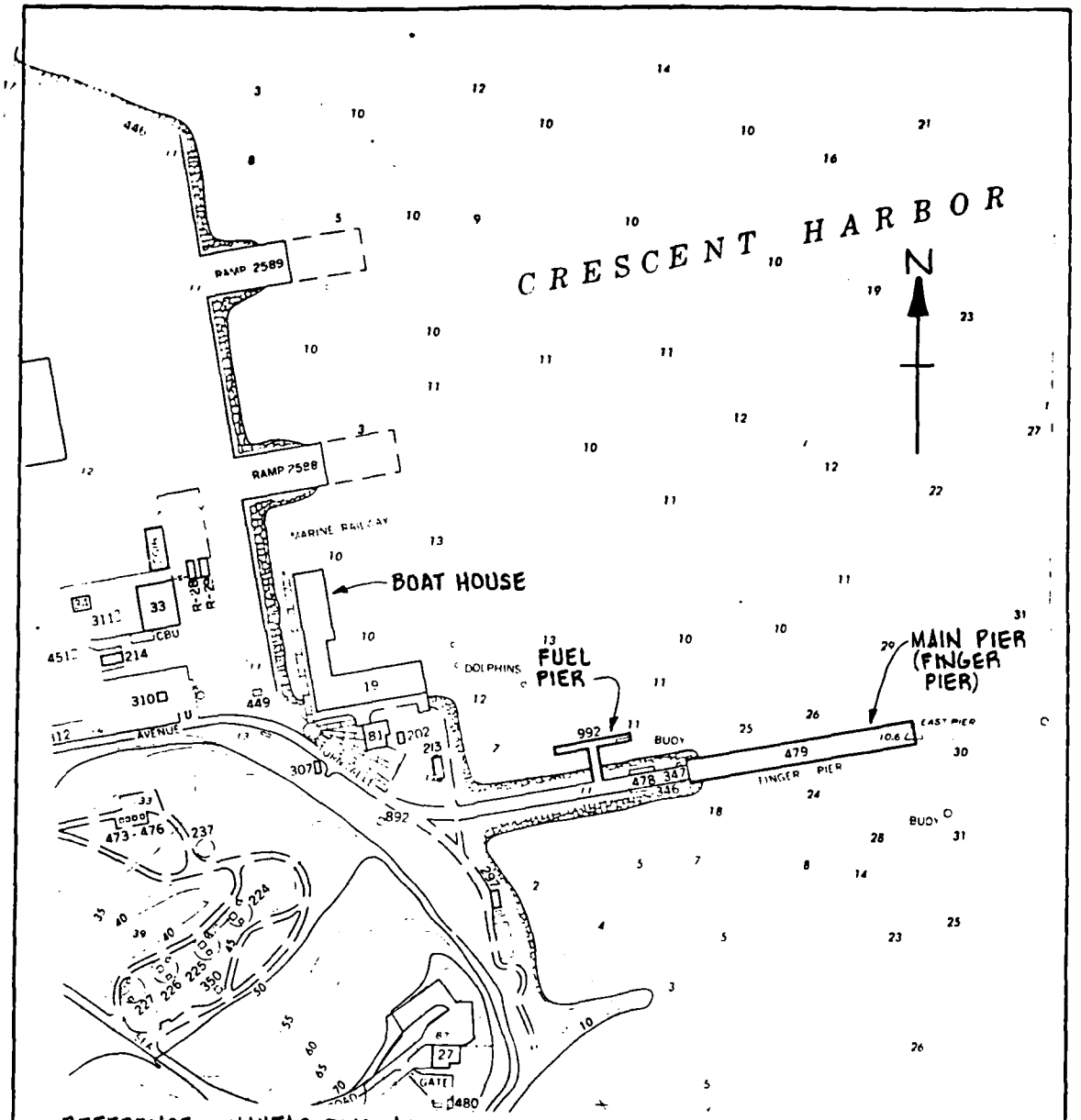
Under this task three (3) facilities were inspected at the Seaplane Base; the Boat House, Fuel Pier and the Main Pier (Finger Pier) (see Figure 3). The only facility inspected at Ault Field was the Runway Approach Lights (see Figure 4) while the remaining facility inspected was the Pumping Station Pier at Dugualla Bay.

TOPOGRAPHY

Whidbey Island was formed by glacial action that gave the island its rolling terrain and gravelly soils. Gentle ridges run the length of the island.

CLIMATE

Whidbey Island has a uniform marine climate. Temperature extremes are modified by prevailing westerly winds from the Pacific. However, the winds seldom attain a high velocity. The average annual temperature is 49.9 degrees Farenheit (ranging from 60.9 degrees in the summer to 38.3 degrees in the winter). The average annual precipitation is 17.73 inches. The relatively low figure is due to a unique rain shadow caused by the Olympic Mountains.



GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 333 MEDFIELD, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D C
NOT TO SCALE		NAVAL AIR STATION WHIDBEY ISLAND, WA — FACILITIES LOCATION — FIG NO 3

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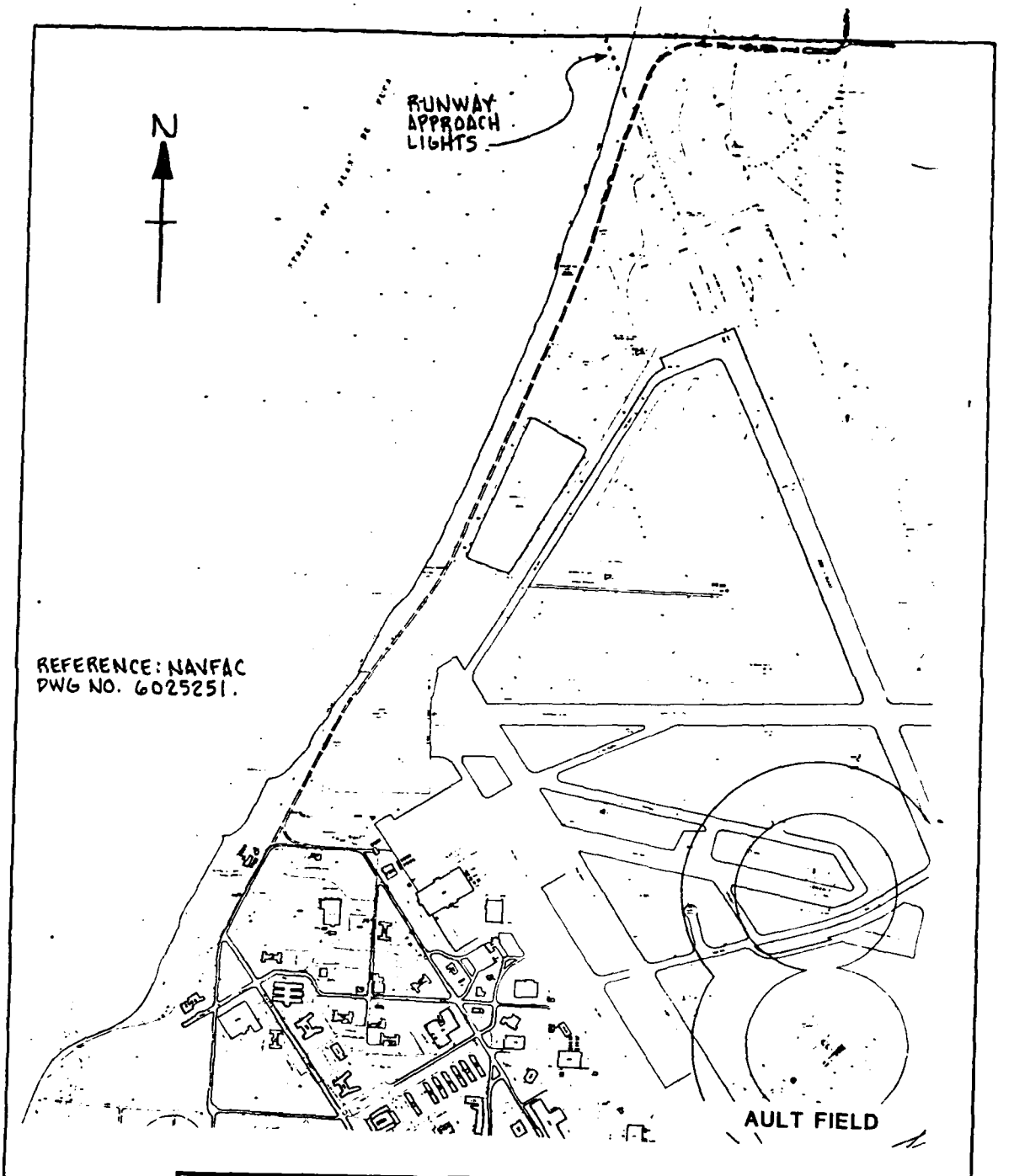

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NOT TO SCALE		NAVAL AIR STATION WHIDBEY ISLAND, WA — FACILITIES LOCATION — FIG NO 4

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SECTION 3.0 INSPECTION PROCEDURE

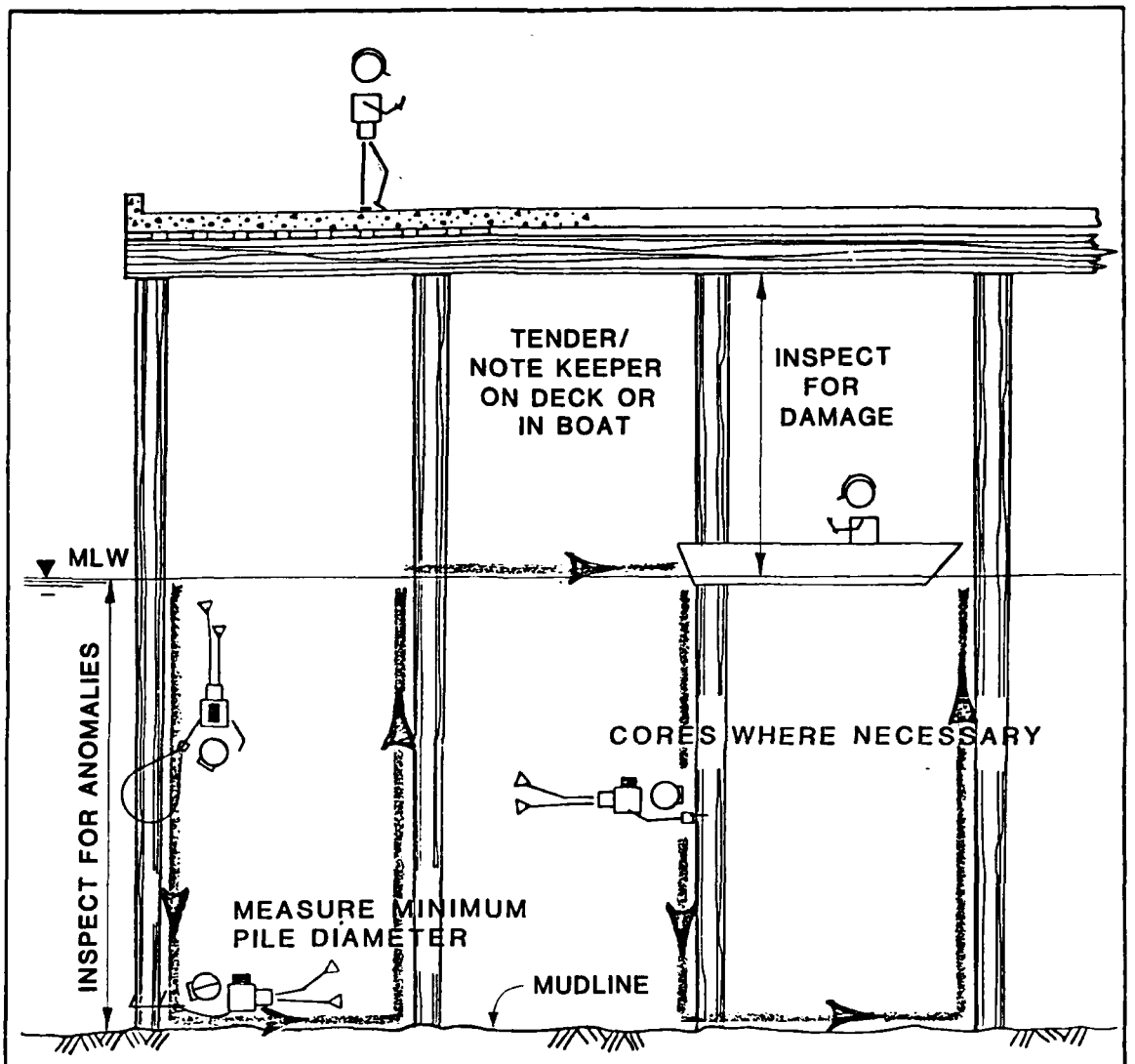
Between August 1 and August 5 of 1983, a three-person Engineer/Diver, Technician/Diver inspection team performed an on-site underwater inspection of various piers and waterfront structures at the Naval Air Station on Whidbey Island, Washington. The level of inspection to be performed, the type of structure being inspected, actual on-site conditions and past experience, combined with a thorough knowledge of engineering theory, dictated the inspection procedures that were followed.

3.1 LEVEL OF INSPECTION

The inspection techniques used had to be sufficient to yield information necessary to make a general condition assessment of the supporting structure of each facility, identify any areas that were mechanically damaged or in advanced states of deterioration and formulate repair and maintenance recommendations with cost estimates. In general, this means utilizing visual/tactile inspection techniques. Photographic documentation of typical as well as unusual conditions were also obtained.

3.2 INSPECTION PROCEDURE

A dive team consisting of two engineer/divers and a tender performed the on-site inspection (see Figure 5). Depending on the layout of the individual pier, the divers either inspected alternate bents or each inspected a portion of a bent. Various levels of inspection were performed on selected piles as delineated below:



TYPICAL DIVER INSPECTION PATH FOR TIMBER PILE INSPECTION

GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 333 MEDFIELD MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON D.C.
NOT TO SCALE		NAVAL AIR STATION WHIDBEY ISLAND, WA — INSPECTION PATH — FIG NO. 5

A Level I general inspection was performed on all perimeter piles within each of the open type structures and on piles within every 3rd bent. This is approximately 40% of the total number of piles. A modified Level I, which is a "swim-by" of every pile at an elevation of two (2) to four (4) feet below the MLW to detect any obvious major damage, was conducted on all remaining piles.

A Level II inspection was performed on 10% of the piles within each open type structure and involved cleaning of piles in the following manner:

Wood Bearing Pile: Band-cleaned around perimeter of pile to a length of 10 inches to expose underlying pile at two heights: MLW (Mean Low Water) and ML (Mudline). Measure minimum diameters.

Steel Bearing Pile: Band-cleaned three sides of pile at two locations, MLW and ML.

Level II piles were chosen at random and differ from Level I piles that were previously observed.

A Level III inspection was performed on 2% of the piles. Level III inspections for wood piles include taking wood cores from the piles. Three (3) core samples were taken at each pile location. A Level III inspection for steel-bearing piles involved taking ultrasonic steel thickness measurements at locations cleaned for Level II inspections.

3.3 INSPECTION EQUIPMENT

Equipment used for the inspection included a Minolta SRT200 camera with 28mm and 200mm lenses and strobe, a Nikonos IVA underwater camera with strobe, pile calipers, pneumatic coring machine, dive lights, sounding tapes, survey tapes, 8-foot folding rules, chipping hammers, dive knives and an ultrasonic thickness measurement instrument.

Choice of equipment was made as a result of past experience. Most of the equipment is straightforward, easy to implement, and has proven reliable under hard use.

SECTION 4.0 FACILITIES INSPECTED

Within this section of the report, each facility inspected at the Naval Air Station, Whidbey Island, Washington, is referenced separately. The discussion of each facility is presented in four parts: 1) a description of the construction and function of the structure, which is derived both from the on-site inspection and from the referenced government-furnished drawings; 2) an enumeration of general and specific conditions observed during the on-site inspection; 3) a qualitative assessment of the structural condition of the facility based on the inspection data; and 4) recommendations for actions to be taken to ensure long-term, cost-effective maintenance and utilization of the facility. Detailed breakdowns of cost estimates are included in the Appendix.

The term "superstructure" is used throughout this report. It refers to that portion of the facility above the splash zone, including, for example, pile caps, beams and the underside of the decking. Only a cursory inspection was made of this area as it was beyond the scope of this project. A more detailed examination of this portion of each facility should be made by the Naval Air Station, particularly in instances where the cursory examination revealed extensive deterioration. This is in keeping with recommendations made in MO-322, Vol. 1, for annual control inspections for waterfront structures.

4.1 FUEL PIER

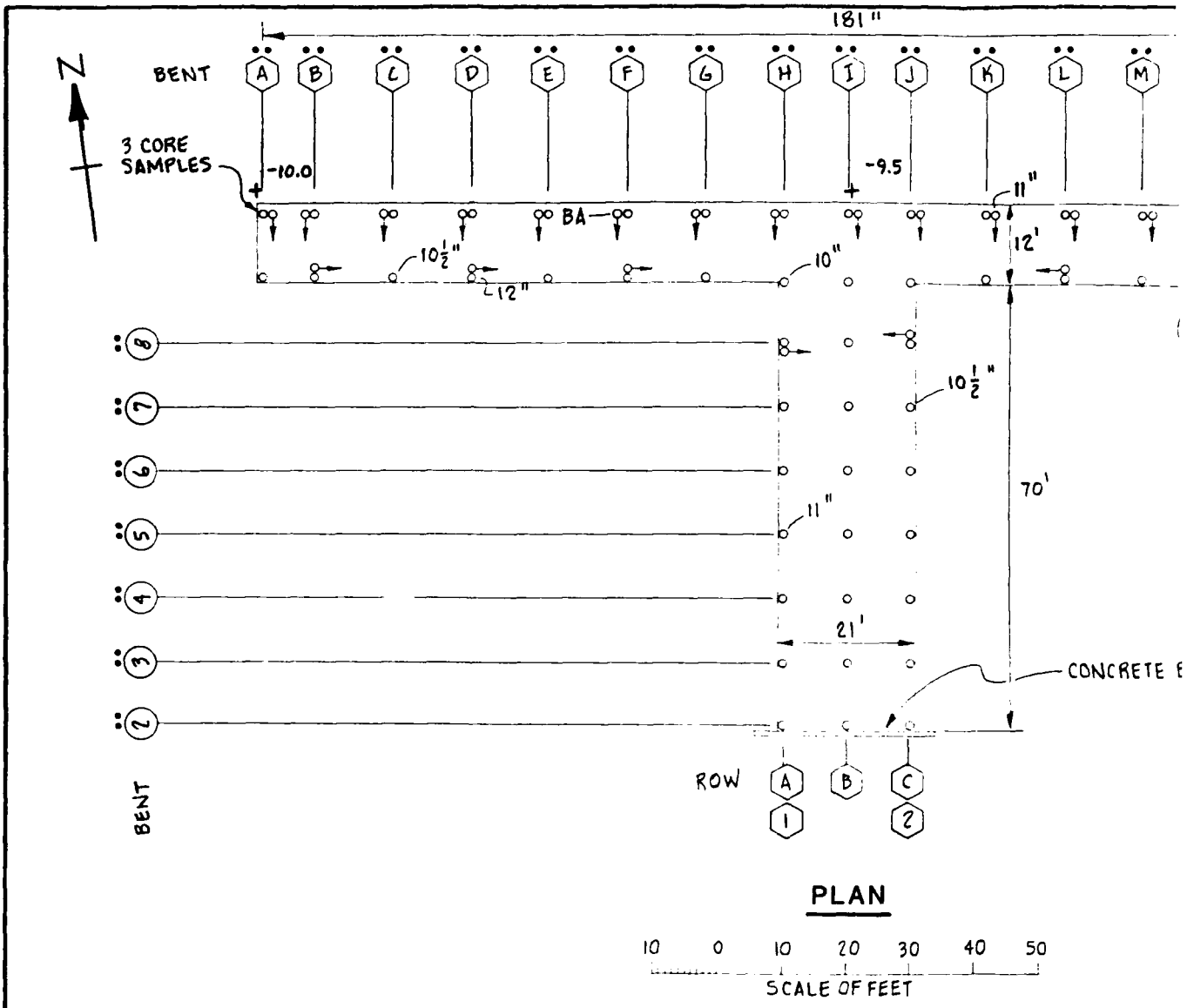
4.1.1 DESCRIPTION

The Fuel Pier is located on the north side of the approach dike to the Main Pier in Crescent Harbor (see Figure 3). During the inspection period this pier was functioning as a petroleum product transfer facility. According to base personnel, it is used primarily to berth barges and off-load petroleum from the barges.

The pier was constructed circa 1968 and is an open pier type structure with a timber deck system supported by treated round timber piles. The approach portion of the pier is 21' wide and extends offshore 70'. The pierhead is 181' long and is 12' wide. There are a total of 55 vertical and 25 battered piles associated with the pier and a 7-pile dolphin located to the east of the pierhead (see Figures 6 and 7).

The pier has a design uniform live-load capacity of 400 pounds per square foot.

Reference: NAVFAC Dwg. No. 1196299 and 1196300

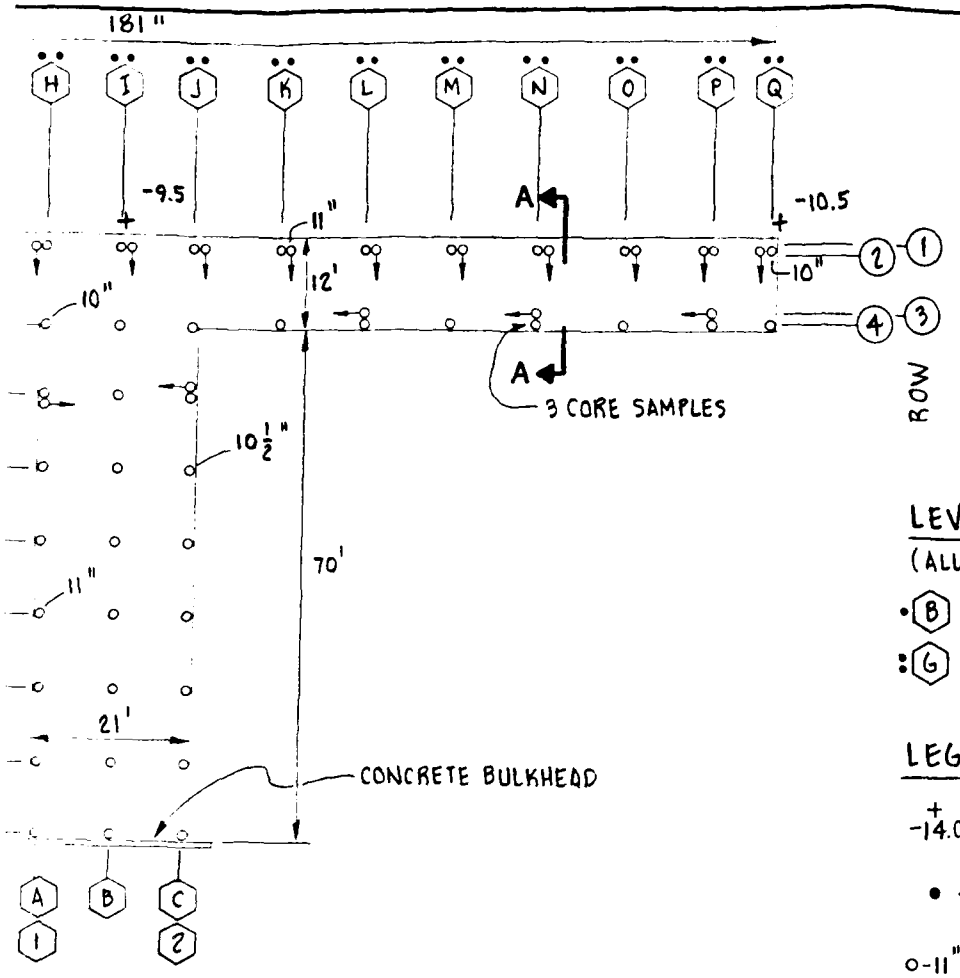


PLAN

10 0 10 20 30 40 50

SCALE OF FEET

REFERENCE FROM: NAVFAC DWG NO. 1196299 & 1196300.



PLAN

10 20 30 40 50

SCALE OF FEET

7-PILE DOLPHIN

LEVEL OF INSPECTION

(ALL PILES WITHIN BENT OR ROW)

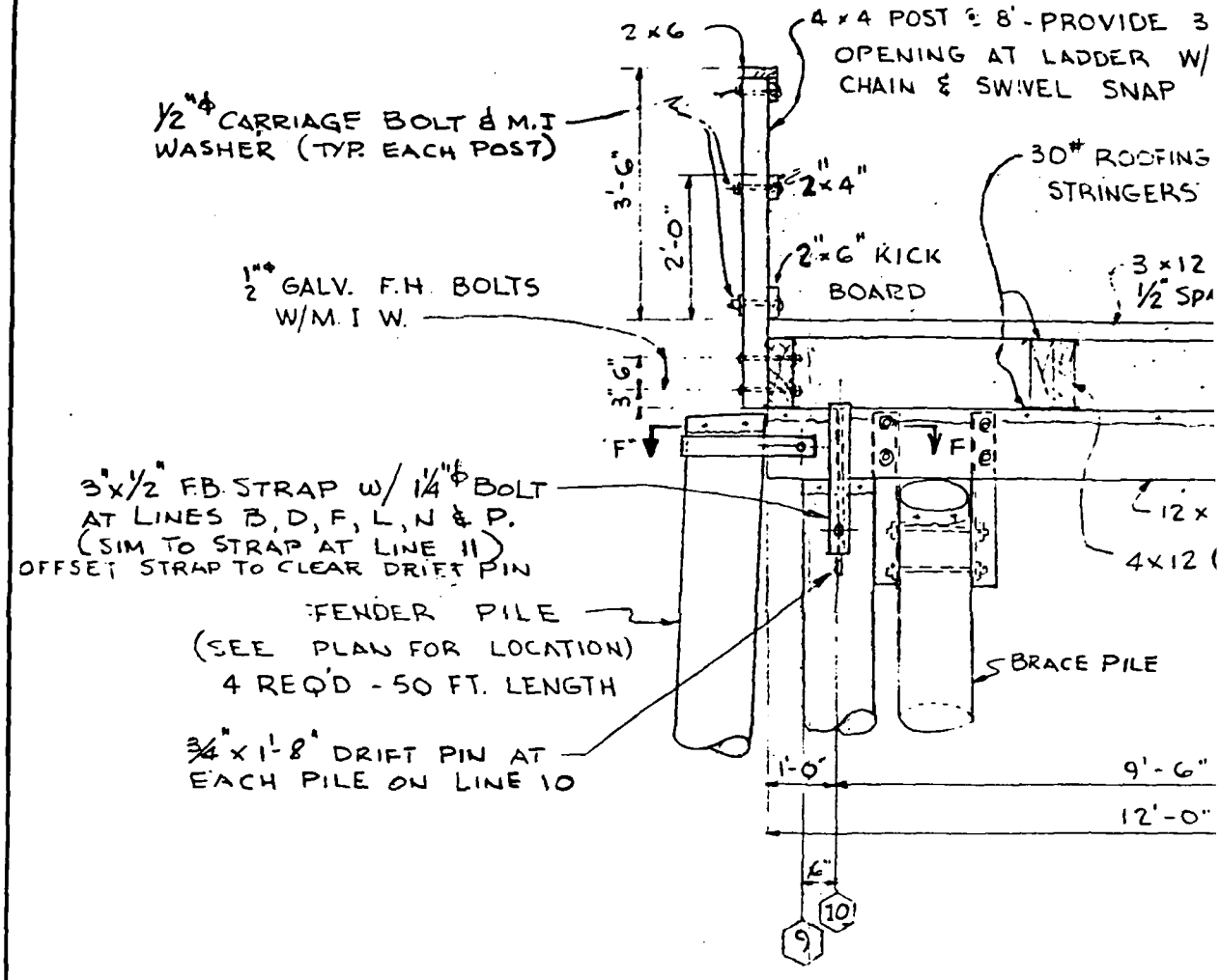
- •B MODIFIED LEVEL I
- :G LEVEL I

LEGEND

- $-^{+}_{14.0}$ - SOUNDING IN FEET BELOW MLLW = EL 0.0
- • - PILE WITH SEVERE STRUCTURAL DAMAGE
- o-11" - MINIMUM RECORDED PILE DIAMETER
- o-BA - EVIDENCE OF MARINE BORER ATTACK

PLAN

GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 333 MEDFIELD MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON D.C.
AS SHOWN		NAVAL AIR STATION WHIDBEY ISLAND, WA — FUEL PIER — FIG NO 6



SECTIO

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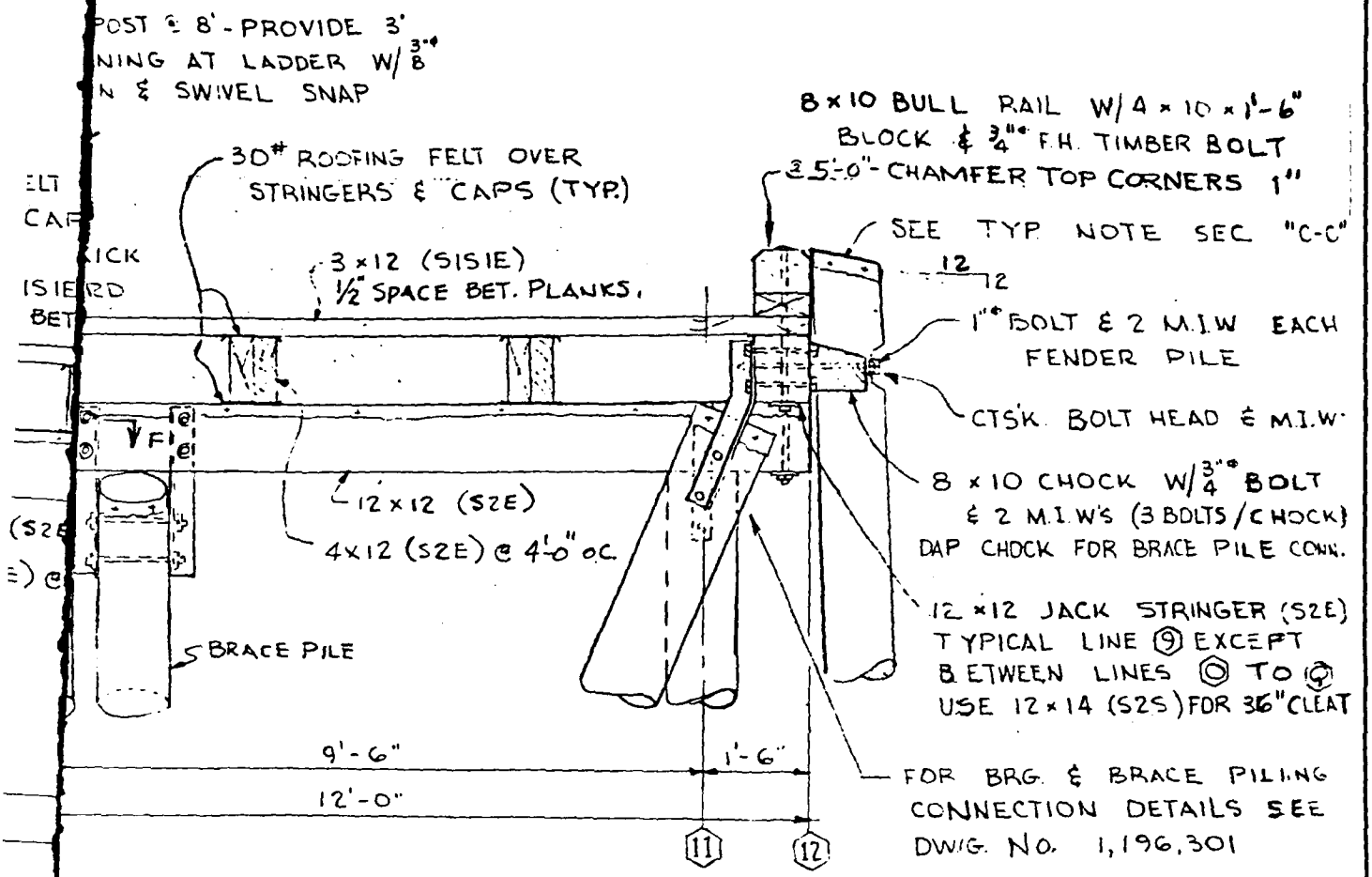
SCALE OF

REFERENCE FROM: NAVFAC DWG NO. 1196300.



SECTION A-A

0 1 2 3 4 5

SCALE OF FEET

TYPICAL SECTION

GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 333 MEDFIELD MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON D.C.
AS SHOWN		NAVAL AIR STATION WHIDBEY ISLAND WA — FUEL PIER — FIG NO 7

4.1.2 OBSERVED INSPECTION CONDITION

Throughout the structure marine growth was observed on the piles. In general, the growth was segregated to various elevations along the pile. In the tidal zone, elevation 0.0 (MLLW) to 9' above MLLW the growth consisted of barnacles, mussels and a variety of marine invertebrates including starfish (see Photo #1). Below MLLW to the mudline marine growth generally consisted of hairlike algae up to 1/4" long, sea urchins and other marine invertebrates (see Photo #2).

In most cases the piles appeared sound. No significant softness in the timber was detected when the piles were probed with a knife. The core samples indicated that the internal wood is sound and the odor of creosote indicates that the preservative treatment is still present in the piles. There does not appear to be any significant loss of pile cross-section.

Evidence of marine borer activity was observed on one pile, Bent F, Pile 2. Entrance holes created by shipworms, probably Bankia, were found near the mudline. Some minor abrasion was observed on several piles (see Photo #3). This damage appeared to be the result of scraping and may be the result of the pile installation process.

The major structural anomaly was observed on two (2) of the piles associated with the 7-pile dolphin. The two (2) northern piles

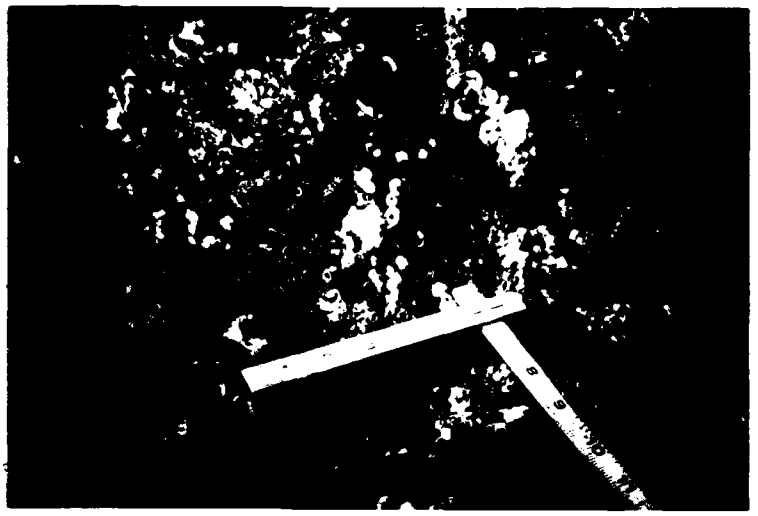
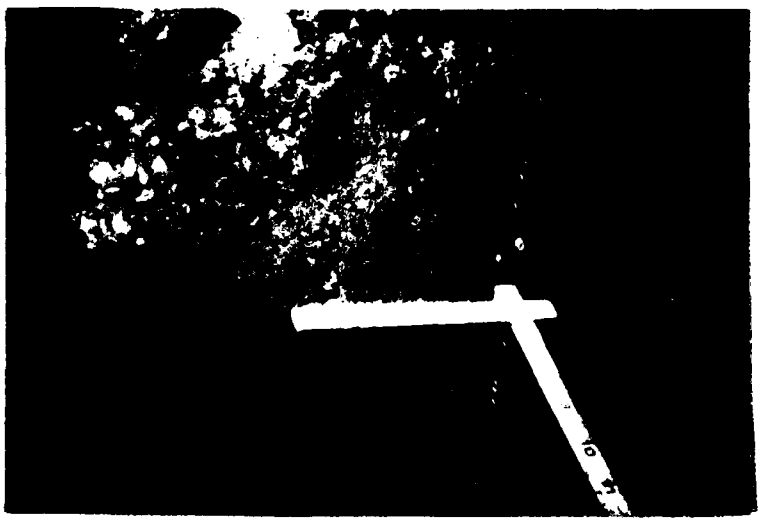


PHOTO #1: Bent 4, Pile B, El. +2.0
Typical marine growth in the tidal zone.

PHOTO #2: Bent 5, Pile B, El. -3.0
Typical marine growth below tidal zone
to mudline.



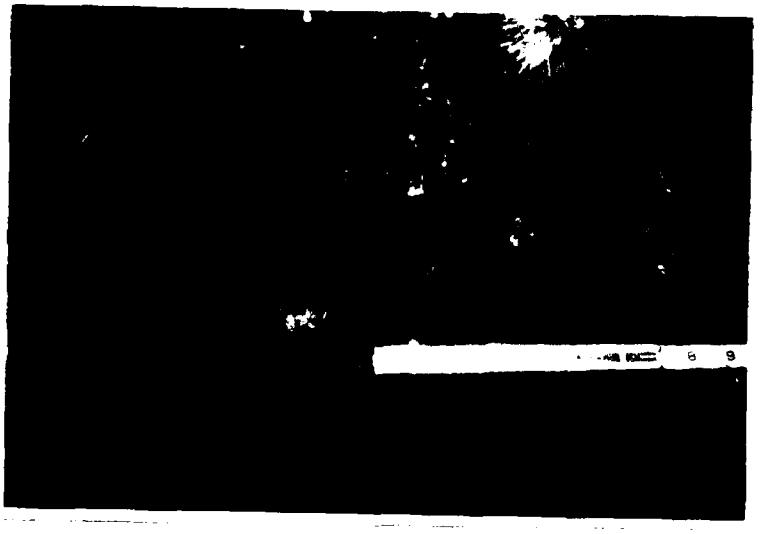


PHOTO #3: Bent C, Pile 2, Elev. -8.0
Typical scraping observed on several piles. Probably the result of the pile installation process.

are broken approximately 3' below MLLW. It appears the breaks are the result of impact from a berthing vessel (for location see Figure 6.

A cursory inspection of the underside of the superstructure (decking, stringers and pile caps) indicates that they are in good condition. No significant deterioration such as fungal attack (dry rot) was noted.

4.1.3 STRUCTURAL CONDITION ASSESSMENT

The pier support piles are generally in good condition. The observed conditions are consistent with that of other structures of similar age and construction subjected to the same environment.

The two (2) broken piles found in the 7-pile dolphin have seriously reduced this structure's capacity to resist berthing loads. If these piles are not repaired, it is possible that the dolphin will fail if it is subjected to a significant impact.

The condition of the pier support piles indicates that they are still capable of handling the original design live-loads. The observed pile scraping is cosmetic and does not effect the pile structurally.

The presence of marine borers can be a serious problem. Although not structurally significant at this time, their presence indicates that the preservative treatment in the piles may be deteriorating. If, over time, a major marine borer infestation occurs, the piles will lose capacity to support the imposed loads.

4.1.4 RECOMMENDATIONS

To return the 7-pile dolphin to design capacity, the two (2) broken piles should be replaced. It is estimated that the cost of this repair is approximately $8,400.00.

Based on the observed presence of marine borers, it is recommended that action be taken to mitigate current borer activity and prevent future borer infestation. One method of protecting piles from marine borer activity is to wrap them from the high water level to below the mudline with a plastic barrier. The pile wrap isolates the timber from fresh, oxygenated water, thereby creating an unsuitable environment for the borers. It is estimated that wrapping 80 piles will cost approximately $18,000.

The pier should be re-inspected at the completion of the repair work to determine the adequacy and condition of the repairs. It should be re-inspected at an interval not to exceed 5 years. This report should be used as a datum or baseline for comparison purposes for that inspection.

4.2 MAIN PIER (FINGER PIER)

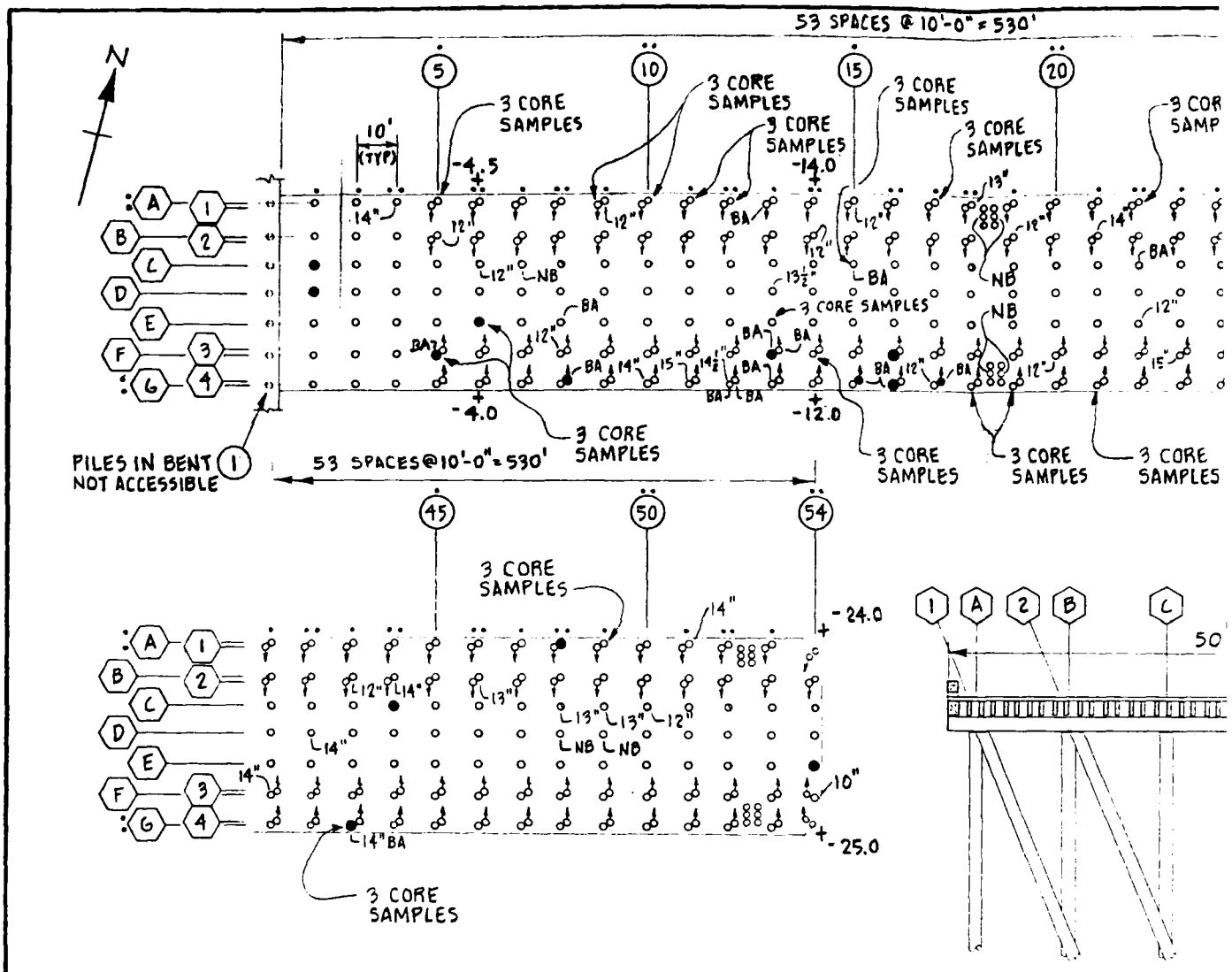
4.2.1 DESCRIPTION

The Main Pier is the southeasternmost facility in the Crescent Harbor complex. The pier is located at the eastern end of a rubble mound-type approach dike (see Figure 3). During the inspection the pier was being used as a recreational fishing pier and vehicular access was restricted.

The available information indicates that the pier was restored in 1949, however, it is estimated that the original construction is circa 1942 when the base was first activated. The pier is an open-type structure with treated round timber piles supporting timber pile caps, stringers and a timber deck (a small portion of the deck is concrete).

The pier is approximately 530' long and 50' wide. Typical pile bents include 7 vertical piles and 4 battered piles. There are approximately 364 vertical piles and 196 battered piles associated with the pier. An additional 36 vertical piles provide support for the mooring bollards (see Figure 8).

Reference Y & D Drawing No. 1029430, 63-140



PLAN

10 0 10 30 60 90

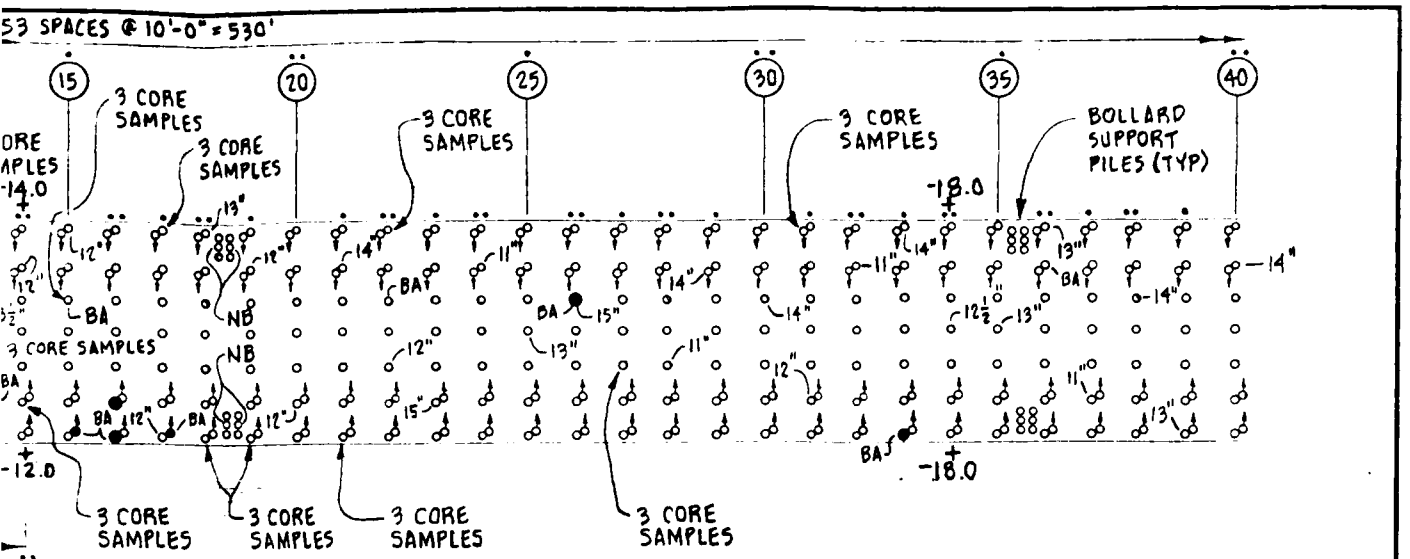
SCALE OF FEET

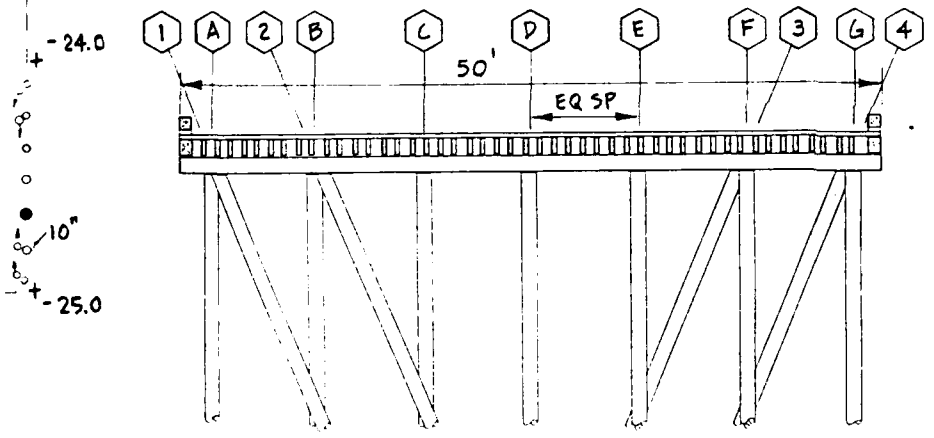
TYPICAL C

5 0 5

SCA

REFERENCE FROM: Y&D DWG NOS. 1029430, 63-140.





TYPICAL CROSS-SECTION

5 0 5 10 15 20

SCALE OF FEET

LEVEL OF INSPECTION

(ALL PILES WITHIN BENT OR ROW)

- (B) MODIFIED LEVEL I
- (G) LEVEL I

LEGEND

- $^{+}_{-}14.0$ - SOUNDING IN FEET BELOW MLLW = EL 0.0
- • - PILE WITH SEVERE STRUCTURAL DAMAGE
- o-11" - MINIMUM RECORDED PILE DIAMETER
- o-BA - EVIDENCE OF MARINE BORER ATTACK
- o-NB - NON-BEARING

PLAN & SECTION

GRAPHIC SCALE		CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON D.C.	
AS SHOWN	CHILDS ENGINEERING CORPORATION BOX 333 MEDFIELD MA	NAVAL AIR STATION WHIDBEY ISLAND WA MAIN PIER (FINGER PIER)	FIG NO 8

4.2.2 OBSERVED INSPECTION CONDITION

In general, the marine growth profile is similar to the Fuel Pier. In the tidal zone barnacles and mussels are predominant organisms. Mussel growth is up to 4" thick in many cases. From MLLW to the mudline, there are no mussels and little sporadic patches of barnacles. Generally the piles are covered with a hairlike algae up to 1" thick and there are anemones, sea urchins, and starfish scattered on the piles.

A cursory inspection of the superstructure indicated that, in general, the decking, stringers and pile caps are sound although some fungus (dry rot) damage was observed at the ends of the pile caps.

The major structural anomalies associated with the piles included significant marine borer attack, impact damage, non-bearing piles and severe mechanical damage. Piles which have undergone severe borer damage and are no longer structurally functional are: (see Photos #4, #5 and #6)

Bent 43, Pile G
Bent 33, Pile G
Bent 26, Pile C
Bent 17, Pile 4
Bent 16, Pile G
Bent 15, Pile 4
Bent 13, Pile F
Bent 8, Pile 4
Bent 5, Pile F

Piles which have suffered impact and are no longer structurally functional include:

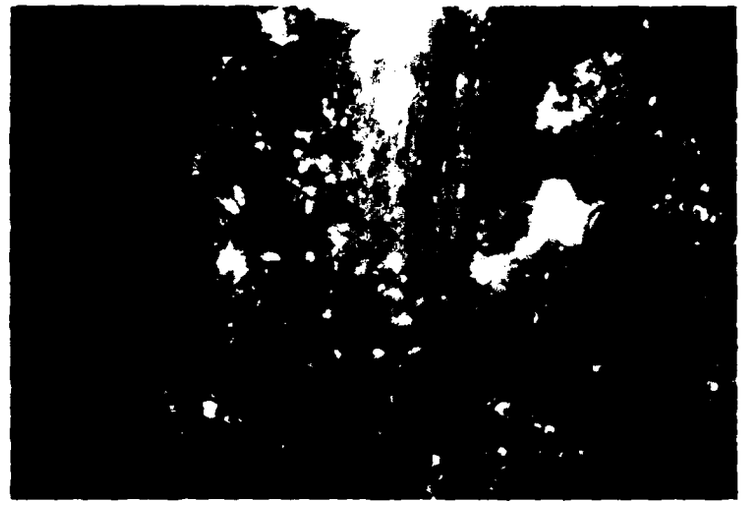


PHOTO #4: Bent 15, Pile 4, El. +5.0
Typical severe damage caused by marine borers.

PHOTO #5: Bent 26, Pile C, El. -2.0
Typical severe damage caused by marine borers.

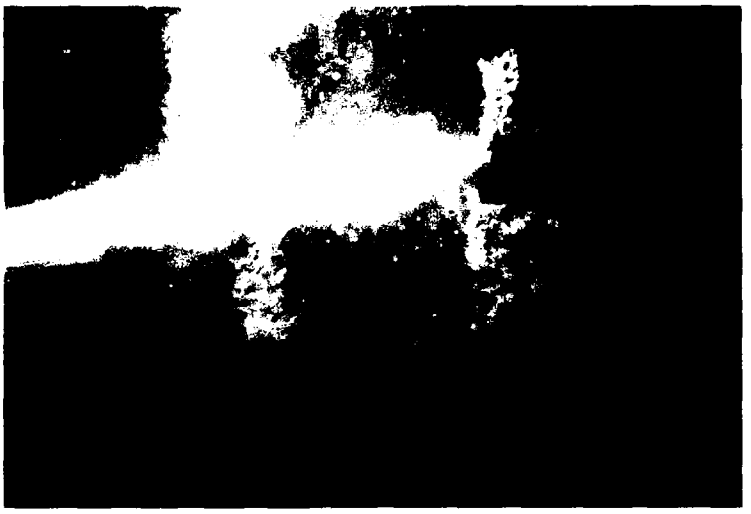


PHOTO #6: Bent 43, Pile G, El. -5.0
Typical severe damage caused by marine borers.

Bent 54, Pile E
Bent 48, Pile A

Several piles are missing including:

Bent 44, Pile C
Bent 16, Pile F
Bent 2, Pile C
Bent 2, Pile D

There are also several piles which are not bearing at the pile cap including:

Bent 7, Pile C
Bent 48, Pile D
Bent 49, Pile D

One pile, Bent 6, Pile E, exhibited severe mechanical damage. The pilehead is split along the top 6' and the pile is only 10% bearing on the cap.

In addition to the piles with severe structural damage, many piles exhibited signs of marine borer attack, but the damage appears minor and no significant loss of structural capacity is assumed. Those piles not observed to have specific anomalies appeared to be in good condition. These piles, when probed with a knife, are sound and in general exhibit little or no softness (see Photo #7). Core samples indicated the internal timber is still sound and that the preservative treatment is present (see Photo #8).

Four piles associated with the mooring bollards between Bents 18 and 19 are non-bearing. It appears that these piles were intentionally omitted from the concrete pile cap which supports the bollard.

PHOTO #7: Bent 18, Pile A, El. -2.0
Typical cleaned location for Level II inspection.

PHOTO #8: Bent 49, Pile A, Mudline
Typical timber core location.

4.2.3 STRUCTURAL CONDITION ASSESSMENT

The piles which are structurally damaged have reduced the pier's live-load capacity. Based on calculations the original live-load pier capacity was approximately 430 pounds per square foot. Presently the two (2) missing piles in Bent 2 restrict live-loading to 98 psf. It should be noted, however, that any form of vehicular traffic would probably exceed this load capacity since it would be a concentrated loading.

Although the most significant live-load capacity reduction is at Bent 2, the random location of other damaged piles would reduce the remaining pier deck live-load capacity to 220 psf along the interior of the pier and 240 psf around the perimeter.

The presence of active marine borer attack, both by gribbles *(Limnoria) and shipworms (Bankia), poses a* potential structural problem. Although the number of piles which have been attacked is relatively small, the presence of marine borers indicate that the preservative treatment may be weakening and, in some cases, that sufficient mechanical damage has occurred to the piles, allowing the borers access into the untreated wood. In any case, it can be anticipated that an increase in structurally-damaged piles will result unless the piles are protected from the marine borers.

The effect of the non-bearing piles associated with the mooring bollards between Bents 18 and 19 should be investigated based on anticipated bollard loading. Since bollard load is dependent on the size and type vessel to be berthed, this analysis can only be undertaken when this information is determined.

4.2.4 RECOMMENDATIONS

In order to restore the live-load capacity of the pier to original design levels, the severely-damaged piles must be repaired. The nine (9) piles which are no longer functional as a result of borer attack and the one (1) mechanically-damaged pile should be posted. This repair technique removes the damaged section of pile and replaces it with a new segment of a treated round timber pile. The estimated cost to post these ten (10) piles is $10,000. The two (2) piles which are broken as a result of impact damage should be removed and replaced with new piles. The estimated cost for this replacement is $4,000. The four (4) pier support piles which are missing should be replaced. The estimated cost to replace these piles is $7,000. All non-bearing piles should be shimmed with hardwood to create full bearing and refastened. Estimated cost to shim four piles is $1,000. To prevent additional damage by marine borers all of the structural piles should be wrapped with a protective barrier. The estimated cost to wrap 560 piles is $252,000. The effect of the four (4) non-bearing piles associated with the mooring bollards between Bents 18 and 19 should be determined.

After the repairs the pier should be re-inspected to determine the adequacy and condition of the repairs. The pier should be re-inspected at an interval not to exceed 5 years. This report should be used as a datum or baseline for comparison purposes for that inspection.

4.3 BOAT HOUSE

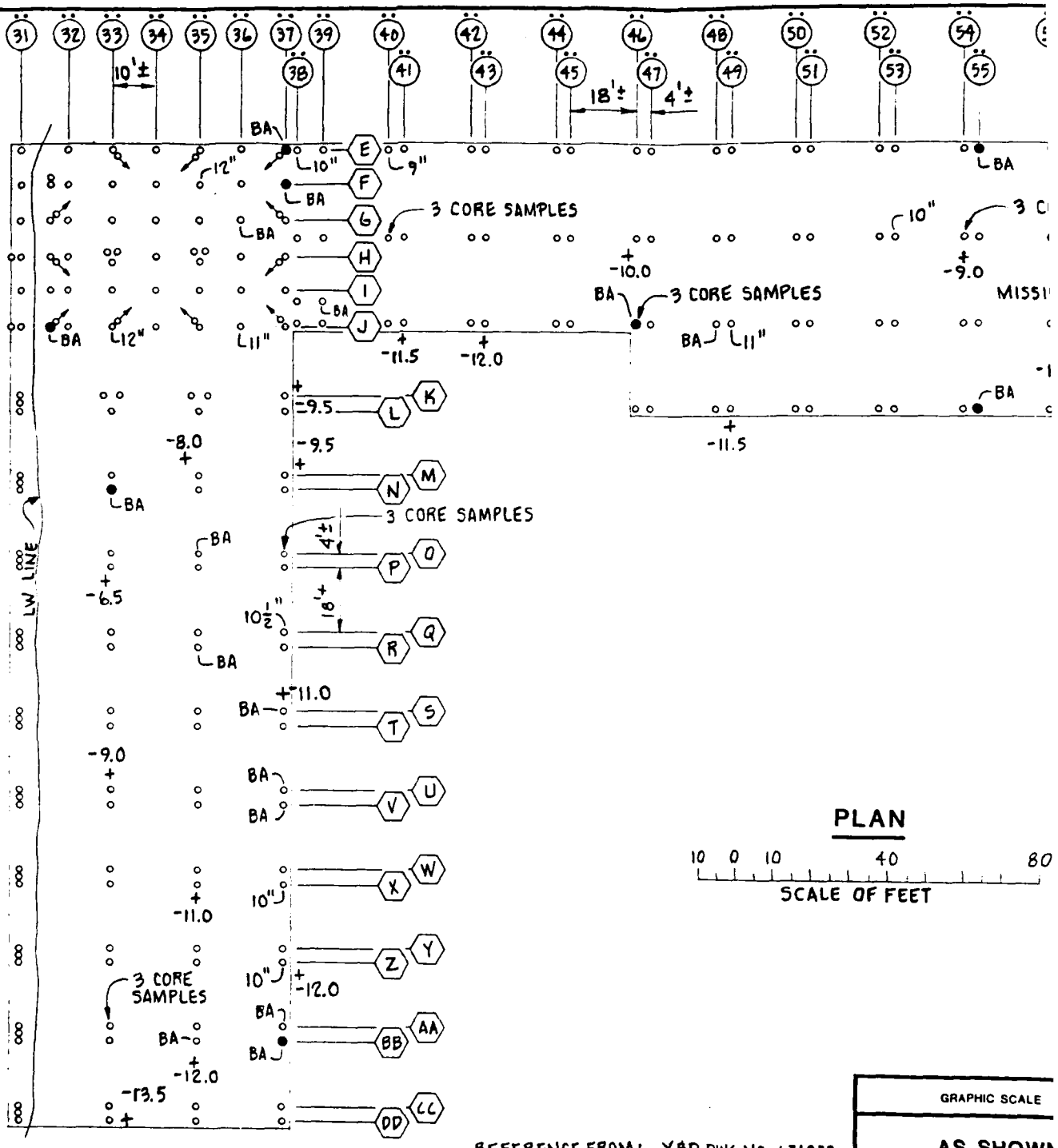
4.3.1 DESCRIPTION

The Boat House is the westernmost facility in the Crescent Harbor complex located adjacent to the western end of the rubble mound-type approach dike for the Main Pier (see Figure 3). The primary function of the Boat House is for berthing small pleasure craft in a semi-enclosed environment.

The available information indicates that the facility was built circa 1942. The Boat House is an open-type structure with treated round timber piles supporting a timber superstructure and timber roof.

The facility is an "L" shaped structure with principal east-west dimensions of approximately 325' long by 70' wide and north-south dimensions of 220' long by 75' wide. There are approximately 261 vertical piles supporting the Boat House structure (see Figure 9).

Reference: Y & D Drawing NO. 671233



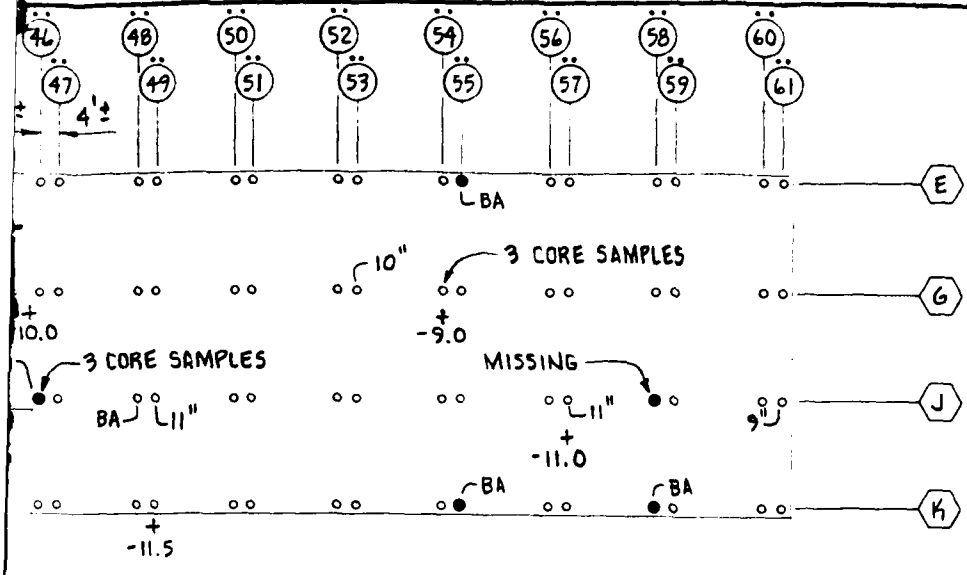
PLAN

10 0 10 40 80

SCALE OF FEET

REFERENCE FROM: Y&D DWG NO. 671233.

GRAPHIC SCALE
AS SHOWN



LEVEL OF INSPECTION

(ALL PILES WITHIN BENT OR ROW)

- (B) MODIFIED LEVEL I
- (G) LEVEL I

LEGEND

- $-\overset{+}{14.0}$ - SOUNDING IN FEET BELOW MLLW = EL 0.0
- ● - PILE WITH SEVERE STRUCTURAL DAMAGE
- o-11" - MINIMUM RECORDED PILE DIAMETER
- o-BA - EVIDENCE OF MARINE BORER ATTACK

PLAN

10 0 10 40 80

SCALE OF FEET

PLAN

GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 333 MEDFIELD MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D C	
AS SHOWN		NAVAL AIR STATION WHIDBEY ISLAND, WA BOAT HOUSE	FIG NO 9

FROM: Y&D DWG NO. 671233.

4.3.2 OBSERVED INSPECTION CONDITION

In general, the marine growth profile is similar to the Fuel Pier and the Main Pier. In the tidal zone barnacles and mussels are the predominant organisms. Mussel growth is up to 4" thick in many cases. From MLLW to the mudline, there are no mussels and little sporadic patches of barnacles. Generally the piles are covered with a hairlike algae up to 1" thick and there are anemones, sea urchins, and starfish scattered on the piles.

A cursory inspection of the superstructure indicated that, in general, the structural support timber and roofing members are sound although some fungus (dry rot) damage was observed at the ends of some of the members.

The major structural anomaly associated with the piles is marine borer attack. Piles which are severely damaged as a result of borer attack and no longer structurally functional are: (see Photo #9)

Bent 37, Pile E
Bent 37, Pile F
Bent 32, Pile J
Bent 46, Pile J
Bent 55, Pile E
Bent 55, Pile K
Bent 58, Pile K
Bent 33, Pile N
Bent 37, Pile BB

In addition to the marine borer damage one pile was noted as missing, Bent 58, Pile J.

In addition to the piles with severe structural damage, many piles exhibited signs of marine borer attack, but the damage appears

PHOTO #9: Pile E, Bent 37, E. +5.0
Illustration of severe structural damage to pile as a result of marine borer attack. Note also the heavy mussel and barnacle growth.

minor and it is estimated that no significant loss of structural capacity has occurred (see Photos #10 and #11).

Those piles not observed to have specific anomalies appeared to be in good condition. These piles, when probed with a knife, are sound and exhibit little or no softness. Core samples indicated the internal timber is still sound and that the preservative treatment is present.

PHOTO #10: Pile J, Bent 46, El. -8.0
Illustration of marine borer trenches and entrance holes. Damage to pile is not considered severe.

PHOTO #11: Pile K, Bent 55, El. -10.0
Illustration of marine borer entrance holes.

4.3.3 STRUCTURAL CONDITION ASSESSMENT

Determination of the effects of the missing and damaged piles on the integrity of the Boat House structure requires either a review of the original design calculations or a detailed analysis of the complete structure. Apparently the original design data is not available, therefore a detailed structural analysis of the facility is necessary. A detailed analysis is beyond the scope of this program and should be undertaken by the cognizant authority. One aspect of the detailed analysis which is included in the scope of this project is the current capacity of the existing piles. Based on a review of the available information it is estimated that the driven capacity of the piles is twenty (20) tons. Analysis of a typical structural pile indicates that the column capacity is 7.7 tons. Piles with severe structural damage are estimated to have a column capacity of approximately 5.4 tons.

The effect of the missing pile on the overall stability of the Boat House structure should also be investigated. That no local failure of the roof structure in the area of the missing pile was observed is probably due to the change in the roof support structure (i.e., addition of a carrying beam between piles adjacent to the missing pile).

4.3.4 RECOMMENDATIONS

In order to restore the column capacity of the severely damaged piles to original design levels these piles should be repaired. The nine (9) piles which are severely damaged as a result of borer attack should be structurally rebuilt. One repair technique would be to encase the damaged section of pile in a reinforced concrete jacket. The estimated cost to encase these nine piles is $15,975. If analysis of the structure indicates that the missing pile should be replaced it is estimated that this repair would cost $2,000.

It is recommended that action be taken to mitigate current borer activity and prevent future borer infestation. One method of protecting piles from marine borer activity is to wrap them from the high water level to below the mudline with a plastic barrier. The pile wrap isolates the timber from fresh, oxygenated water, thereby creating an unsuitable environment for the borers. It is estimated that wrapping 252 piles will cost approximately $56,700.

At the completion of the recommended repairs, the structure should be re-inspected to determine the adequacy and condition of the repairs. The piles should be re-inspected at an interval not to exceed 5 years. This report should be used as a datum or baseline for comparison purposes for that inspection.

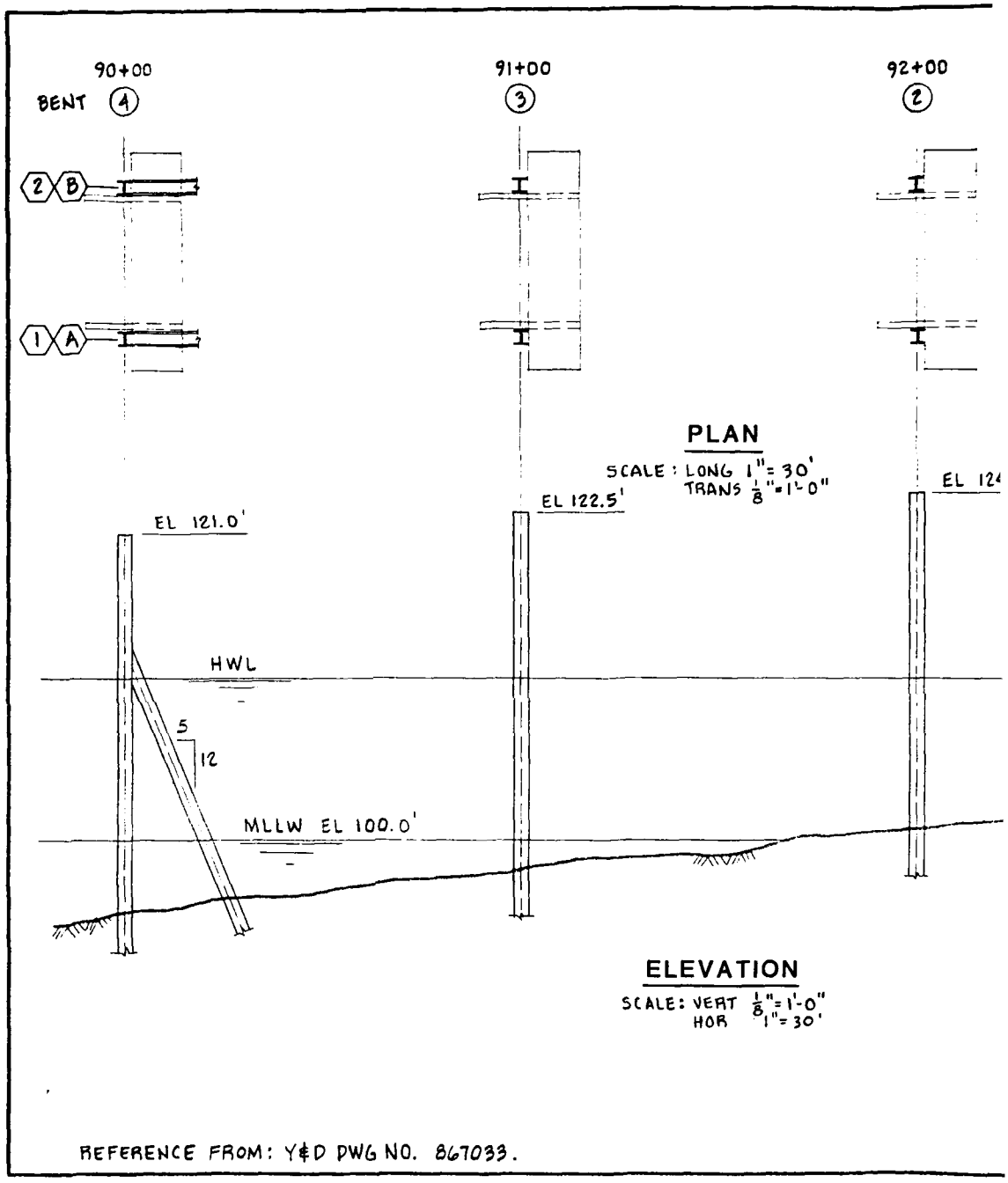
4.4 RUNWAY APPROACH LIGHTS

4.4.1 DESCRIPTION

The Approach Lights are located at the north end of Runway 13/31 at the Ault Field complex in the Strait of Juan de Fuca (see Figure 4). The Approach Lights' pile supports were constructed circa 1970.

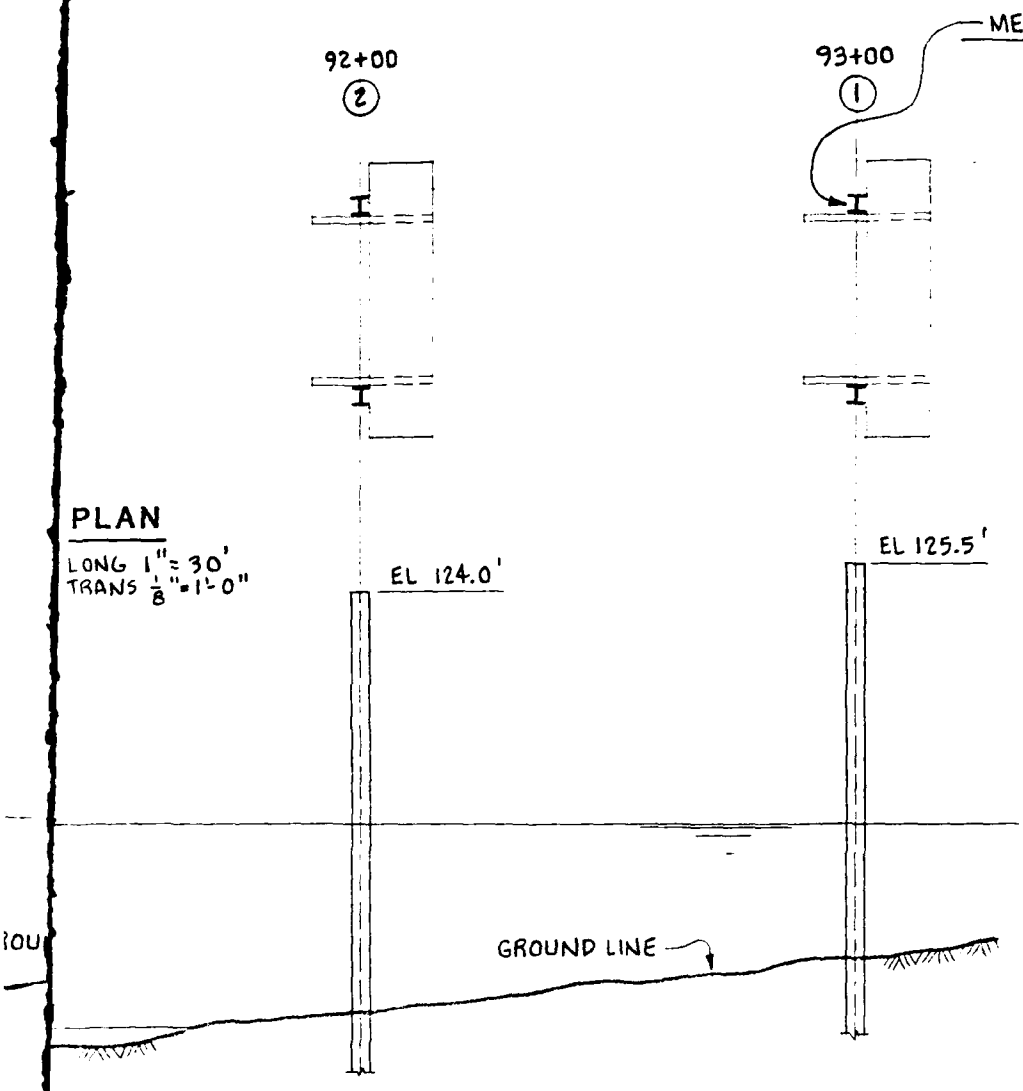
The portion of the Approach Lights system which extend below high water level includes four (4) pile bents. Three of the bents are composed of two (2) steel H-piles supporting a working platform and a bar of lights, while the fourth bent has two (2) vertical steel H-piles and two (2) battered steel H-piles (see Figure 10).

Reference: Y & D Drawing NO. 867033



REFERENCE FROM: Y&D DWG NO. 867033.

JOB 498-82 Whidbey Isl. NAS



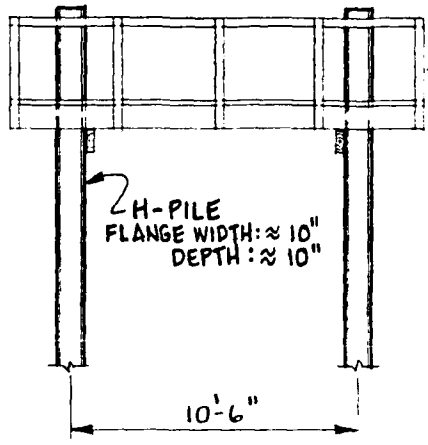
PLAN

LONG 1" = 30'
TRANS $\frac{1}{8}$" = 1'-0"

METAL THICKNESS MEASUREMENTS:

(THICKNESS-IN.)

ELEV	FLANGE	WEB
101.0	.425	.310
103.0	.420	.255
105.0	.440	.270



TYPICAL CROSS-SECTION

SCALE: $\frac{3}{16}$" = 1'-0"

NOTE WELL:

ALL PILES RECIEVED A LEVEL I INSPECTION.

EVATION

E: VERT $\frac{1}{8}$" = 1'-0"
HOR 1" = 30'

PLAN, SECTION & ELEVATION

GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 333 MEDFIELD, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON D.C.	
AS NOTED		NAVAL AIR STATION WHIDBEY ISLAND, WA RUNWAY APPROACH LIGHTS	FIG NO 10

4.4.2 OBSERVED INSPECTION CONDITION

Typical marine growth includes thick layers of barnacles from the high water level to 1' above the mudline. Sporadic patches of seaweed and kelp were also noted.

No significant structural anomalies were noted during the inspection of the Approach Light piles. Some corrosion of the steel was noted, however, it is not structurally significant (see Photo #12).

The piles were originally equipped with sacrificial anodes (probably aluminum). Most of the anodes are still in place, but two (2) anodes are missing (see Photo #13). In general, the anodes have lost some cross-section indicating that they are actively protecting the piles.

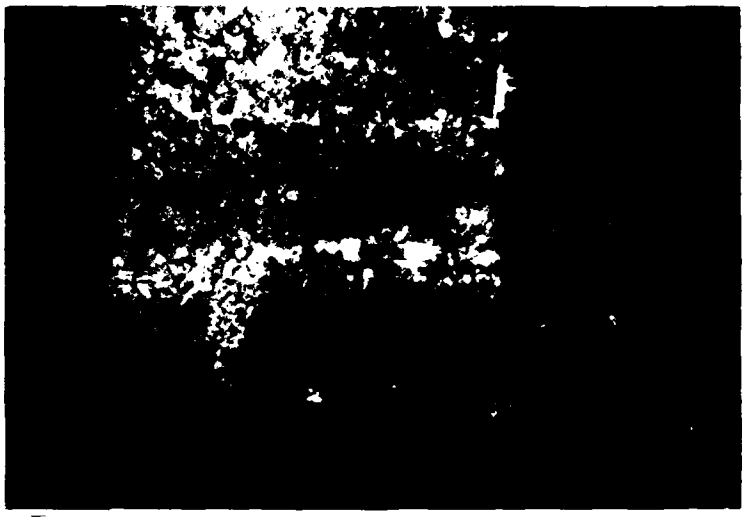


PHOTO #12: Pile A, Bent 1, El. +105.0
Illustration of typical condition of sheet pile. Note horizontal weld joint in cleaned section.

PHOTO #13: Pile B, Bent 1, El. +103.0
Illustration of typical location of thickness measurement. Note bolt used to attach anode (anode is missing).

4.4.3 STRUCTURAL CONDITION ASSESSMENT

The Approach Lights' support piles are in good condition. The corrosion which has occurred to date is not structurally significant.

4.4.4 RECOMMENDATIONS

No structural repairs are required at this time. It is recommended that the two (2) anodes which are missing be replaced. The cost to replace the missing anodes is estimated to be $500.00.

Regular annual inspection of the anodes is recommended and when anodes have lost their usefulness, they should be replaced. The Runway Approach Lights should be re-inspected in five years. This report should be used as a baseline for future inspections.

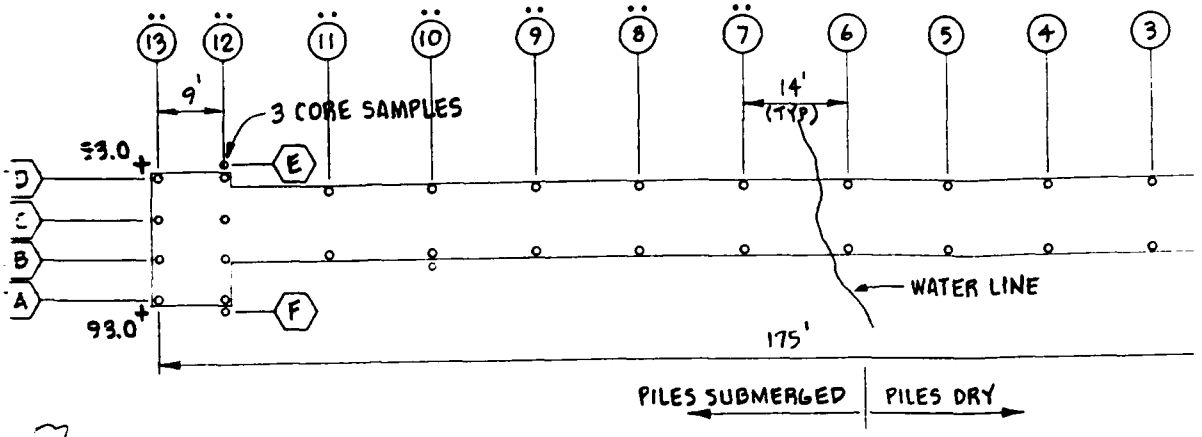
4.5 PUMPING STATION PIER

4.5.1 DESCRIPTION

The Pumping Station Pier is located in Dugualla Bay. The pier supports piping associated with a storm drain system.

The pier was constructed circa 1956 and is an open pier-type structure approximately 175' long and 10' wide. A timber deck system is supported by a total of 35 vertical treated round timber piles (see Figure 11).

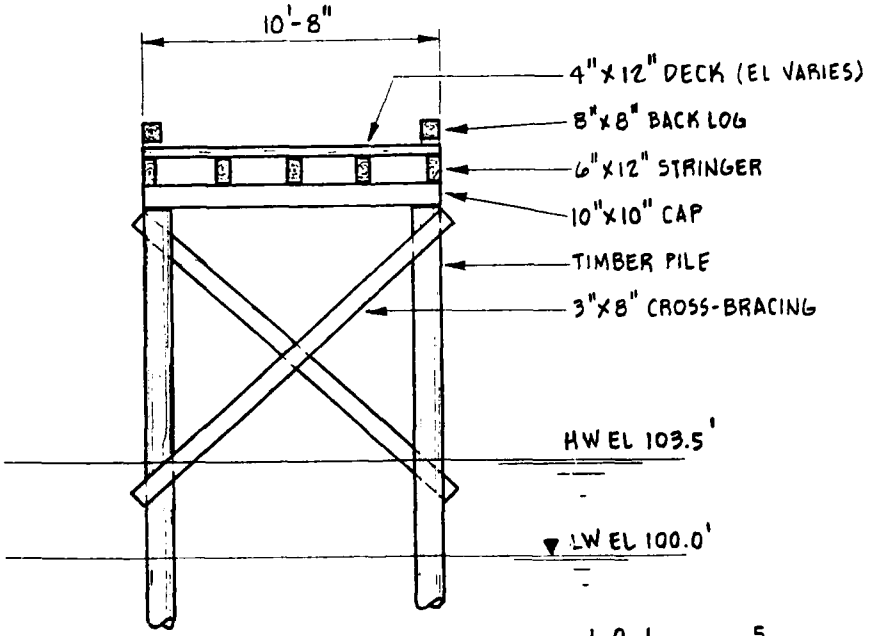
Reference: Y & D Drawing No. 597993 and 597994



DUGUALLA BAY

PLAN

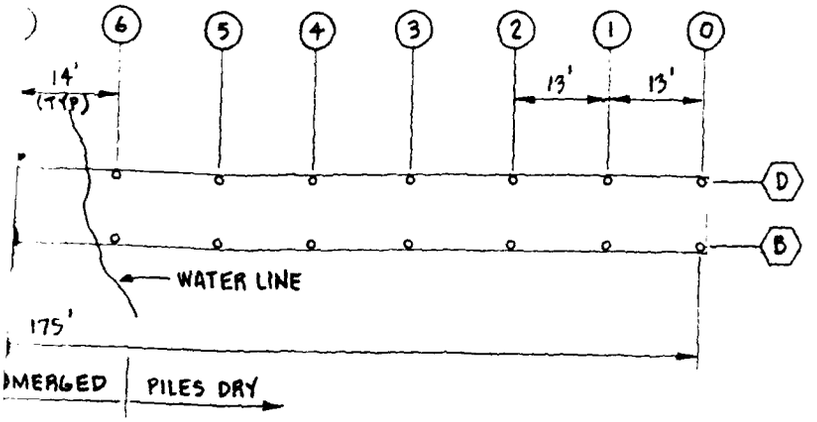
10 0 10 20 30 40 50
SCALE OF FEET



TYPICAL CROSS-SECTION

1 0 1 5 10
SCALE OF FEET

REFERENCE FROM: Y&D DWG NO. 597993/4.



PLAN

20 30 40 50

LE OF FEET

(EL VARIES)

16

ER

SRACING

LEVEL OF INSPECTION

(ALL PILES WITHIN BENT OR ROW)

- (B) MODIFIED LEVEL I
- (G) LEVEL I

LEGEND

93.0 + - ELEVATION IN FEET, LW EL = 100.0'

PLAN & SECTION

5 10

OF FEET

GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 333 MEDFIELD, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON D C
AS SHOWN		NAVAL AIR STATION WHIDBEY ISLAND, WA PUMPING STATION PIER — FIG NO 11

4.5.2 OBSERVED INSPECTION CONDITION

In general, the growth on the piles consisted of fresh water algae up to 1/4" thick and since the piles are primarily in fresh water, no marine borer activity was noted. No anomolies were noted for the submerged portion of the piles and a cursory inspection of the superstructure indicated that it was also in good condition. Core samples taken from the piles appeared sound and the presence of treatment was noted.

4.5.3 STRUCTURAL CONDITION ASSESSMENT

The Pumping Station Pier is in good condition. The piles were found to have no structural degradation.

4.5.4 RECOMMENDATIONS

No repairs are recommended at this time. The pier should be re-inspected in five years. This report should be used as a baseline for future inspections.

CHILDS ENGINEERING CORPORATION
Box 333
MEDFIELD, MA 02052

JOB 498-82 Whidbey Isl. NAS
SHEET NO 1 OF
CALCULATED BY DLP DATE Oct, 1983
CHECKED BY RGF DATE Oct 1983
SCALE

Fuel Pier: Repair Cost Estimate

Repair 2 broken piles in the 7-pile dolphin.

Demolition: Unwrap wire rope @ Remove completely damaged piles Lump Sum	$3000.
Repair: Drive 2 new treated piles 2 @ $1200	$2400.
Rewrap wire rope	3000.
	$8400.

Protective pile wrap -

Ave. exposed pile length 15'

PVC wrap complete-in-place $15/L.F.

80 piles x 15'/pile = 1200 L.F.

1200 L.F. x $15/L.F. = $18,000

Total repair cost for Fuel Pier = $26,400.

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JOB 498-82 Whidbey Isl. NAS
SHEET NO 2 OF
CALCULATED BY DLP DATE 10/83
CHECKED BY RGF DATE Oct 1983
SCALE

Main Pier - Live load capacity.

Assumptions - driven capacity of piles - 20+

Capacity Limit By Pile Analysis -

bents 10' o.c. pile space 8.33'

Area = 83 ft

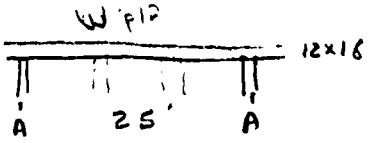
Live Load = Pile cap/Area - Dead Load =

= 40,000/83.3(psf) - 50 p.s.f

= 430 psf

Access limited by loss of two(2) piles in first pile bent.

Check capacity of cap



f_b = 1800 psi (assume)
$S_x = \frac{bd^2}{6}$ = 512 in³

M_{max} = 1800(6.12) = 921600 in-#
= 76800 ft-#

$M = \frac{wl^2}{8} = 76800$

w = 983 plf

Based on 10' bent spacing
Live load capacity = 983#/10'
= 98 psf

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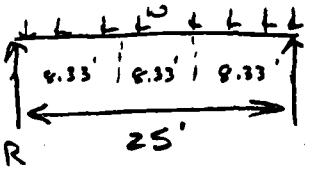
JOB 498-82 Whidbey Isl. NAS
SHEET NO 3 OF
CALCULATED BY DLP DATE 10/83
CHECKED BY RGF DATE 10/83
SCALE

check load on pile - A:

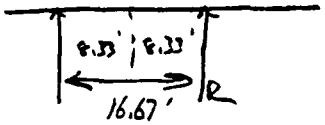
$w = 983$ plf



$$R = wl/2 = \frac{983\#/1(25')}{2} = 12,288\# = 6.1 \text{ ton} < 20^t$$
O.k.

Pile are capable of supporting reduced uniform load over greater span.

Pier capacity reduction where interior pile is damaged:



cap - $M_{max} = 76,800^{in\#}$ (can psf)

$M = \frac{wl^2}{8}$ or $w = \frac{M(8)}{l^2}$

$w = \frac{76800(8)}{(16.67)^2} = 2211$ plf

Uniform load = $w/10'$ (count spans)

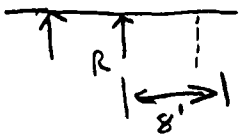
= 221 psf

$R = wl/2 = \frac{2211(16.67)}{2} \approx 9 \text{ ton} < 20^t$
O.k.

CHILDS ENGINEERING CORPORATION
Box 333
MEDFIELD, MA 02052

JOB 498-82 Whidbey Isl. NAS
SHEET NO. 1 OF
CALCULATED BY DLP DATE 10/83
CHECKED BY RGF DATE 10/83
SCALE

Pier capacity reduction at damaged perimeter pile -



$M_{max} = 76,800'\text{-}\#$

$M = \frac{wl^2}{2}$ or

$w = \frac{M(2)}{l^2} = \frac{76800(2)}{(8)^2} =$

2400 plf at 10' bent spacing

Uniform load = $2400/10 =$ 240 psf

$R = wl = 2400(8) = 9.6^{ton} < 20^{t}$ o.k.

CHILDS ENGINEERING CORPORATION
Box 333
MEDFIELD, MA 02052

JOB 498-82 Whidbey Isl. NAS
SHEET NO 5 OF
CALCULATED BY DLP DATE 10/83
CHECKED BY RGF DATE 10/83
SCALE

Main Pier (Con't.)

Cost Estimate

10 piles to be posted:

$1000 per post complete in-place.

10 × $1000 = $10,000

2 piles remove and replace:

remove pile - 2 @ $500 = $1000
drive new pile and reharden - 2 @ $1500 = $3000
$4000

4 piles replace:

cut hole in deck and patch deck after pile is installed. 4 @ $250 = $1000

drive new piles and reharden. 4 @ $1500 = $6000
$7000

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MEDFIELD, MA 02052

JOB 498-82 Whidbey Isl. NAS
SHEET NO 6 OF
CALCULATED BY DLP DATE 10/83
CHECKED BY RGF DATE 10/83
SCALE

Main Pier (cont.)

Shim and refasten piles

4@$250 = $1000

Protective Pile Wrap -

Ave. exposed length - 30'

560 piles @ 30' = 16800 L.F.

$15/L.F. x 16800 L.F. = $252,000

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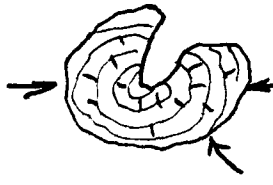
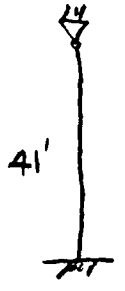
Boat House:

Analysis of typical pile with severe borer damage -



Net remaining cross-section = 70% of original



Pinned at roof.
Free to rotate but translation fixed

$$(\text{Euler}) \quad P = \frac{.274\,(A)\,E}{(l/d)^2}$$

$E = 1.5 \times 10^6$ psi (assumed)

$A = \pi r^2\,(70\%) = \pi(5.5)^2(70)\% = 66.5\ \#$

$l = 41' \times 12'' = 492$

$d = \sqrt{\frac{(11)^2\pi}{4}} = 9.75''$

$$P = \frac{.274\,(66.5)\ 1.5\times10^6}{(492/9.75)^2} = 10734\ \# \approx 5.4 \text{ tons}$$

$$P_{orig} = \frac{.274\,(95)\ 1.5\times10^6}{(492/9.75)^2} = 15333\ \# \approx 7.7 \text{ tons}$$

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JOB 498-82 Wh. Abey Isl. NAS
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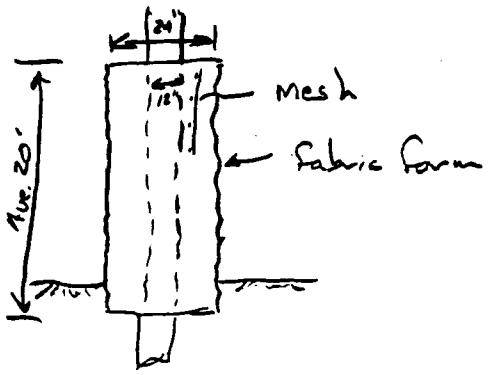
Boat House: Repair Cost Estimate

Structurally rebuilt piles with rein. concrete jacket:



Form + Mesh - L.S. - $500/pile

Concrete - 47 c.f. ≈ 1.75 c.y.

1.75 c.y @ $100 = $175/pile

Labor - Clean pile + installation - 1-3 man crew, 1 day per pile. $1100/pile

$1775/pile

9 × $1775 = $15,975

Protective pile wrap: Ave. exposed length 15'

252 piles × 15' = 3780 c.f. @ $15/c.f. = $56,700

END

DATE
FILMED

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